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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/624,716	07/25/2000	Gi-Joon Nam	X-633 US	6806

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EXAMINER	
KIANERSI, MITRA	

ART UNIT	PAPER NUMBER
2143	5

DATE MAILED: 02/04/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/924,716	GREGOR ET AL.	
	Examiner	Art Unit	
	mitra kianersi	2143	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 03 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 25 November 2003.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-21 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-21 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

Specification

The examiner acknowledges an amendment to the specification filed on 11/25/2003.

Response to Arguments

Applicant's arguments filed 11/25/2003 have been fully considered but they are not persuasive.

Applicant argues on page 2, lines 20-29, that the office action fails to show that Wood et al. teach the limitations relating to a net having multiple solutions and the cited sections of Wood appear to deal with each net having a single routing. Wood et al. teach that by representing the equation as a binary decision diagram (BDD) representing all possible routes for all nets simultaneously (Abstract) and also by representing the resulting satisfiability problem using BDD'S, not only exact routability is determined, but also all feasible routing assignments for nets in the region are determined and incremental perturbations of the global routing constrains are supported. (page 230, col 2. [2])

The dependent claim 4 is not persuasive for the reasons set forth above in regards to claim 1.

Applicant argues on page 7, lines 12-14 regarding claims 5 and 16, that if the rejection is maintained further explanation is need. Wood on page 229, col 1, [4], teach that to generate triple sets for each of the channels, a simple left-edge channel routing algorithm was used to assign nets to tracks followed by back mapping of tracks to channel border pins assuming diagonal switch blocks. Wood also describes Table 1, the benchmark, including dimension, W which is the minimum C-block track count that the global router has determined can be used to complete the detailed embedding of its coarse graphs, number of nets and number of 2-point connects.

The dependent claims 6 and 7 depend from claim 5, and explanation set forth above in regards to claim 1 applies to claims 6 and 7.
Also in regard to claim 7, applicant argues on page 7 lines 22-25 that Wood et al. does not appear to mention a resource table but instead teach a Boolean function that returns a "1" for connected paths. Wood on page 226, col 1,p [2] explains that a large BDD means a large number of routing solutions are possible and a small BDD means few feasible routing. A null "0" BDD means no solution. Also in regard to claim 8 wood discloses on page 224,p [1] explains that a Boolean function over the encoding of net-to-resource assignment that is "1" for connected paths. So in a two function, "0" can be a second function and "1" stands for the first function.
Claims 9 and 10 depend from claim1 and the reason set forth is regard to claim 1 applies to claim 9 and 10. In regard to claim 11, wood on page 223, col 1,p [4] discloses that all nets are assigned simultaneously to feasible tracks. And "n" must be known to execute the formulation is a function of the required number of tracks in the final solution. Thus one is forced to continuously reformulate (modify) the problem with in creasing guesses (repeating) at the final track density until satisfiability Boolean function exists.

Claim 12 depend from claim 11, and claim 13 depends from claim 12. There fore, the same reason set forth above in regards to claim 11 applies to claim 12 and 13. In regard to claim 17-19, applicant argues on page 7 lines 22-25 that Wood et al. does not appear to mention a resource table but instead teach a Boolean function that returns a "1" for connected paths. Wood on page 226, col 1,p [2] explains that a large BDD means a large number of routing solutions are possible and a small BDD means few feasible routing. A null "0" BDD means no solution. Also in regard to claim 8 wood discloses on page 224,p [1] explains that a Boolean function over the encoding of net-to-resource assignment that is "1" for connected paths. So in a two function, "0" can be a second function and "1" stands for the first function.

In regard to claim 21, wood on page 223, p[3] discloses Routing via Boolean satisfiability. Therefore, anticipates the same limitation.

Applicant argues on page 9, lines 7-13 that having based the 103 rejections on the single Abramovici reference, the rejection is required to show that Abramovici suggests all the limitations of the base and dependent claims 2-3 and 20.

In regard to above mention claims, wood teach the Boolean and Exclusivity functions, but Wood et al. do not teach the routability function in Conjunctive Normal form (CNF). However, Abramovici et al. teach a computational technique for implementing satisfiability algorithms involving testing and design of integrated circuits and other complex devices and systems. Abramovici also characterize satisfiability (SAT), which is a computationally difficult problem with a given Boolean function F (x1, x2,...xn) and where F is set to 1. Typically, F is expressed as product-of-sums, which is also called Conjunctive Normal Form (CNF). Therefore, the motivation states that it would have been obvious for one of ordinary skill in the art at the time the invention was made to employ the routability function in Conjunctive Normal Form (CNF) disclosed by Abramovici to FPGA routing and Routability estimation via Boolean satisfiability disclosed by Wood et al. and by doing so, a reconfigurable hardware platform to process circuits much larger than the available capacity of the platform at the cost of a limited amount of additional processing time. It allows any satisfier implemented with reconfigurable hardware, multiple FPGAs, to process circuits much larger than the available capacity of the FPGAs, it does not require any inter-FPGA signal routing. It can be implemented using a platform that is much simpler and cheaper than a Conventional Logic emulator. Also, significant speed-up inn computational time, up to three orders of magnitude, obtained by the concurrent solving of sub problems, are additional benefits. (col 3, lines 20-42, Abramovici)

Claims 1-21 have been examined.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 4-19, and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by R.Glenn Wood et al. [IEEE Transaction on Very Large Scale Integration (VLSI) System, Vol. 6, No. 2, June 1998].

1. As per claim 1, a computer-implemented method for determining routing feasibility of routing solutions for a plurality of nets, each solution using one or more routing resources, comprising (abstract, lines 4-6),

-generating a first Boolean function with variables representing respective net/solution pairs, wherein each net has an associated set of one or more routing solutions, at least one of the nets has a plurality of routing solutions, and the first function evaluates to true if there exists a set of values for the variables such that at least one of the variables for each net is logically true; generating a second Boolean function using the variables that represent the net/solution pairs, wherein the second function evaluates to true if there exists at least one set of values for the variables such that no resource is used by more than a predetermined number of nets; and outputting

a signal indicating whether there exists at least one set of values for the variables for which the first function and the second function evaluate to true. Wood et al. teach the above limitations by representing the equation as a binary decision diagram (BDD) representing all possible routes for all nets simultaneously (Abstract) and also by representing the resulting satisfiability problem using BDD'S, not only exact routability is determined, but also all feasible routing assignments for nets in the region are determined and incremental perturbations of the global routing constrains are supported. (page 230, col 2. [2])

2. A per claim 4, Wood et al. teach a method, wherein the resources comprise signal routing resources of a field programmable gate array (Pg 222, Col 1, p [2]).

3. As per claim 5, a method, corresponding to generating a net table including respective sets of solutions associated with the nets (Pg 225, Col 1, p [2], lines 2-5).

4. As per claim 6, a method corresponding to generating the first function from the net table (Pg 225, Col 1, p [3]).

5. As per claim 7, a method, corresponding to generating a resource table including respective sets of net/solution pairs associated with the resources, wherein each net/solution pair associated with a resource represents usage of the resource by the net/solution pair (Pg 224, Col 1, part 3).

6. As per claim 8, a method, corresponding to generating the second function from the resource table (Pg 225, Col 4).

7. As per claim 9, a method wherein the predetermined number of nets that can use a resource is 1 (Pg 224, Col 1, Part 3).

8. As per claim 10, a method corresponding to saving as a routing solution the at least one set of values for the variables for which the first function and the second function evaluate to true. (Pg 225, Col 1, Part 2, lines 8-11).

9. As per claim 11, a method corresponding to wherein if there exists no set values for the variables for which first and second functions evaluate to true, then performing the steps of: modifying one or more selected sets of the routing solutions; and repeating the steps of generating first and second functions and outputting the signal. (Pg 223, Col 1, p [4], lines 5-8).

10. As per claim 12, a method adding additional sets of routing solutions. (Pg 223, Col 1, lines 9-11)

11. As per claim 13, the repeating steps continue until predetermined criteria are met. (Pg 223, Col 1, Par 4, lines 8-10).

12. As per independent claim 14, an apparatus for determining routing feasibility of routing solutions for a plurality of nets, each solution using one or more routing resources, comprising: (abstract, lines 4-6),

Means for generating a first Boolean function with variables representing respective net/solution pairs, wherein each net has an associated set of one or more routing solutions, at least one of the nets has a plurality of routing solutions. And the first function evaluates to true if there exists a set of values for the variables such that at least one of the variables for each net is logically true; means for generating a second Boolean function using the variables that represent the net/solution pairs, wherein the second function evaluates to true if there exists at least one set of values for the variables such that no resource is used by more than a predetermined number of nets; means for outputting a signal indicating, whether there exists at least one set of values for the variables for which the first function and the second function evaluate to true . Wood et al. teach the above limitations by representing the equation as a binary

decision diagram (BDD) representing all possible routes for all nets simultaneously (Abstract) and also by representing the resulting satisfiability problem using BDD'S, not only exact routability is determined, but also all feasible routing assignments for nets in the region are determined and incremental perturbations of the global routing constrains are supported. (page 230, col 2. [2])

13. As per independent claim 15, a computer-implemented method corresponding to determining routing feasibility of a plurality of nets sharing a-plurality of resources, comprising: (Pg 225, Col 2, p[2], lines 3-6),

inputting respective sets of one or more solutions associated with the plurality of nets, at least one of the nets having a plurality of routing solutions, and each solution being associated with one or more required resources, assigning respective identifiers to net/solution pairs; generating respective Boolean liveness functions for the nets using the net/solution pairs; generating respective Boolean exclusivity functions using the net/solution pairs for each resource required by two or more nets; generating a routability Boolean function as a logical AND of the liveness functions and exclusivity functions; and testing whether the routability function can be satisfied. Wood et al. teach the above limitations by representing the equation as a binary decision diagram (BDD) representing all possible routes for all nets simultaneously (Abstract) and also by representing the resulting satisfiability problem using BDD'S, not only exact routability is determined, but also all feasible routing assignments for nets in the region are determined and incremental perturbations of the global routing constrains are supported. (page 230, col 2. [2])

14. As per claim 16, a method corresponding to generating a net table including respective sets of solutions associated with the nets. (pg 225, Col 1, Part II, lines 2-5).

15. As per claim 17, a method corresponding to generating a liveness functions from the net table. (Pg 225, Col 1, p [3]).

16. As per claim 18, a method corresponding to the method of generating a resource table including respective sets of net/solution pairs associated with the resources, wherein each net/solution pair associated with a resource represents usage of the resource by the net/solution pair. (PG 224, Col 1, Part 3)

17. As per claim 19, a method corresponding to the generating the exclusivity functions from the resource table. (Pg 224, part 4)

18. As per claim 21, a method corresponding to applying Boolean satisfiability to the routability function. (Routing via Boolean satisfiability is disclosed on Pg 223, p [3])

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 2-3, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Abramovici et al. (US 6,442,732).

As per claims 2-3, and 20, Wood et al. do not teach the Boolean and Exclusivity functions and also the routability function in conjunctive normal form (CNF), however, Abramovici et al. teaches a method corresponding to representing the first and second Boolean function in conjunctive normal form (Pg 1, lines 19-21), applying Boolean satisfiability to first and second function (Pg 1,lines 15-18), and Representing the liveness and exclusivity functions and the routability function in conjunctive normal form (Pg 2, lines 60-67).

One of ordinary skill in the art would have been motivated to use the product-of-sum, which is also called conjunctive normal form (CNF), because doing so would have allowed a reconfigurable hardware platform to process circuits much larger than the available capacity of the platform at the cost of a limited amount of additional processing time. (Pg 3, lines 22-25)

Therefore, it would have been obvious for one of ordinary skill in the art at the time the invention was made to recognize that conjunctive normal form (CNF) could be used in satisfiability algorithms for computational aspects of the integrated circuits and other complex systems and devices.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mitra Kianersi whose telephone number is (703) 305-4650. The examiner can normally be reached on 7:00AM-4:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Wiley can be reached on (703) 308-5221. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-3900.

Mitra Kianersi

Feb/02/2003

DAVID WILEY
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